RINGS OF FIRE

Tire Fire Prevention & Suppression

RINGS OF FIRE

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RINGS OF FIRE

It's not a question of if, but rather a question of when and how much?

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RINGS OF FIRE

Program Goal

To provide fire professionals and enforcement officers, along with waste tire owners and operators, up-to-date information so that you can make informed decisions regarding the outdoor storage of tires.

RINGS OF FIRE

Problem Statement

Tire Volume
Tire Geometry
Environmental Impact

TIRE VOLUME

California
33.3 Million generated annually

Nationally
300 Million generated annually
280 Million in known stockpiles

TIRE GEOMETRY

The hollow doughnut shape traps oxygen and shields the fire from fire fighting agents.

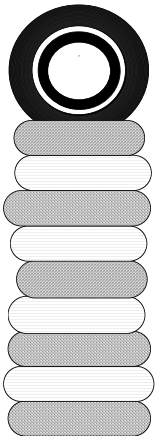
Environmental Impact

Air Pollution

Soil Contamination

Water Quality

Habitat



MAIN MENU

Background

Prevention

Response

Exit

BACKGROUND

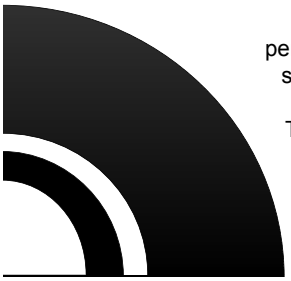
Tire History

Tire Markets

Tire Storage

Main Menu

TIRE HISTORY OBJECTIVE



To provide a historical perspective to the outdoor tire storage problem in America.

To understand the chemical and structural evolution of the modern tire and how it impacts firefighting efforts.

TIRE HISTORY

For thousands of years, South American natives used latex from the rubber tree to waterproof their sandals, baskets and canoes.

TIRE HISTORY

1839	Charles Goodyear invented vulcanization.
1888	John Dunlop made the first air filled tire.
1895	Andre Michelin used air filled tires on a automotive for a 350 mile race in France.
1903	First patent for a tubeless tire.
1908	Grooves were cut for traction.
1910	Carbon added to reduce wear.
1920	Life expectancy was 13,000 miles.
1937	First synthetic tires were produced
1950	Half the tire is manmade rubber.
1954	First tubeless tire on the market.

TIRE HISTORY

Bias Ply -vs- Steel Belts

The greatest impact on the tire storage problem is the transition from bias ply tires to steel belted tires.

Steel belted radial passenger tires are not retreaded.

TIRE CHEMISTRY

Natural & Synthetic Rubber
Sulfur & Sulfur Compounds
Phenolic Resin
Oil & Petroleum Waxes
Fabric (Rayon, Nylon, Polyester) & Wire
Clay, Carbon Black & Inert Material
Fatty Acids
Zinc Oxide, Titanium Dioxide

TIRE CHEMISTRY

FIRE CONDITIONS

Volatile Organics

Polynuclear Aromatic Hydrocarbons

Carbon Monoxide

Heavy Metals

TIRE CHEMISTRY

WESTLEY EMISSIONS

AIR
141,000 lbs OF BENZENE
70,000 lbs OF PAHs
10,000 lbs OF BUTADIENE

PYROLYTIC OIL
250,000 GALLONS RECOVERED

OIL FLOWING INTO CREEK IGNITED

TIRE CHEMISTRY

COMPARISON OF OIL

Benzene 880	Benzene 20
Toluene 2600	Toluene 380
Xylene 2100	Xylene 550
Napthalene 710	Napthalene 330
Lead 3.4	Lead 240
Zinc 830	Zinc 480
Flashpoint 120 F	Flashpoint 140 F

History Questions

1. Should water be used to fight a tire fire when rubber is naturally waterproof?
2. How does the tire grooves affect fire behavior?
3. What happens to air filled tires in a fire environment? How can it be avoided?

BACKGROUND

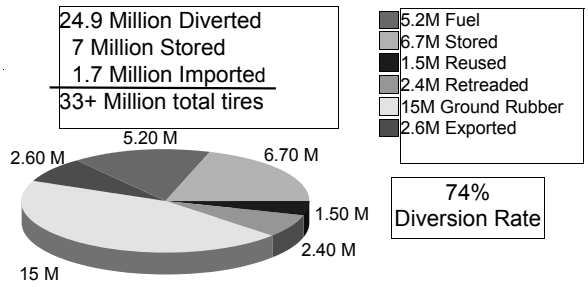
Tire History
Tire Markets
Tire Storage
Main Menu

TIRE MARKET OBJECTIVE

To cite how waste tires are being used in products and engineering applications.

To identify waste storage operations and location.

TIRE MARKET



TIRE MARKET

Retreading
Ground Rubber
Civil Engineering
Fuel Supplement

TIRE MARKET

Retreading

Primarily truck tires.
Old tread is removed, the casing is buffed and a new tread is reapplied.

Retreading shops generate combustible rubber dust.

TIRE MARKET

Ground Rubber

Products made from ground rubber:
athletic mats, running tracks, playground chips, carpet padding, shock absorbers, stock feeders, door mats, gloves, hockey pucks, mud flaps, speed bumps, soaker hoses, and rubberized asphalt.

TIRE MARKET

Rubberized Asphalt

Rubberized Asphalt Concrete (RAC) or
Rubberized Modified Asphalt (RMA)

800 to 1200 waste tires used per mile of a two-lane, 3 inch lift roadway

TIRE MARKET

Ground Rubber

Ground rubber processing involves a steady feed stock of waste tires on site.

Ground rubber processing fires are common.

TIRE MARKET

Civil Engineering

Applications include: artificial reefs, retaining walls, crash barriers, alternative daily cover, loose fill, slope stabilization, levee slurry walls, and landfill leachate collection systems.
ASTM 6270
Civil Engineering Applications of Scrap Tires

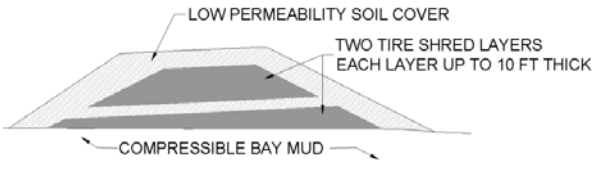
TIRE MARKET

Civil Engineering

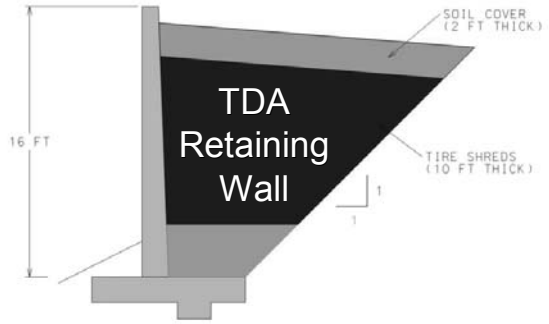
Tire Derived Aggregate (TDA)
Half the weight of soil
Half the pressure of soil
Good thermal insulating qualities
Better drainage than soil
Vibration dampening
56 million tires a year used for C.E.

TIRE MARKET

Civil Engineering
TDA for Highway Interchange



TIRE MARKET



TIRE MARKET

Fuel Supplement

Tires used as fuel supplement in cement kilns, paper and pulp mills, lumber mills, and co-generation power plants.

Cement kilns consumed the largest amount- 4.2 million tires.

HEAT RELEASE

btu/ pound	kilojoules /kilogram	fuel types
18,000	41,940	FUEL OIL
15,000	34,950	SCRAP TIRE
13,500	31,455	PETROLEUM COKE
12,000	27,960	BITUMINOUS COAL
7,800	18,174	SAWDUST
7,400	17,242	NEWSPAPER
3,500	8,100	SOLID MUNICIPAL WASTE

TIRE MARKET

Combustion Byproducts

Calcium Sulfate (gypsum)- agricultural additive
Zinc Oxide (fly ash)- smelting, fertilizer and feed
Iron Oxide (furnace)- Cement production

MARKET QUESTIONS

1. Name three uses for waste tires.
2. How much energy is generated from a pound of tire material?
3. Where could you locate a large feed stock of waste tires?

BACKGROUND

Tire History
Tire Markets
Tire Storage
Main Menu

TIRE STORAGE OBJECTIVE

To identify waste tire storage methods.

To determine the best storage methods from a firefighting perspective.

TIRE STORAGE

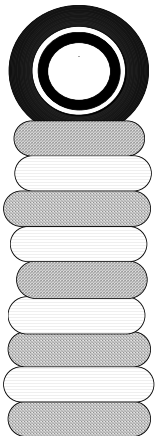
Laced Stack
Bagel Cut
Barrel Stack
Random Stack
Bundled Tires
Baled Tires
Tire Chunks
TDF or TDA

RINGS OF FIRE

Part I
Introduction

STORAGE QUESTIONS

1. What is the typical method for outdoor storage of waste tires?
2. Does storage configuration affect fire behavior?
3. What storage method would you prefer if the tire pile was on fire?



MAIN MENU

- Background
- Prevention
- Response
- Exit

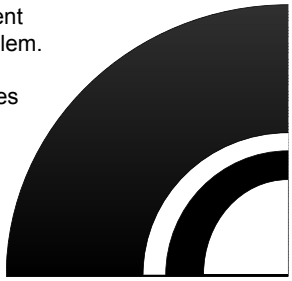
Fire Prevention

- Ignition Sources
- Codes & Regs
- Ground Rubber
- Main Menu

SOURCES OF IGNITION

To further define the extent of the waste tire fire problem.

To identify historic sources of ignition to better apply fire prevention measures at waste tire pile sites.



Ignition Sources

Wildland Fires
Lightening Strikes
Accidental Starts
Arson

TIRE FIRE HISTORY

Tire Fire History

Between 1996 - 1998
59 tire fires were reported across the country involving approximately 20 million tires stored outdoors.

TIRE FIRE HISTORY

Year	Amount	Event
1999	7 M	Westley, California
1998	8 M	Tracy, California
1997	3 M	Gila River, Arizona
1996	2 M	Fresno, California
1993	3 M	Inwood, West Virginia
1990	12 M	Hagersville, Ontario
1990	3 M	Saint Amable, Quebec
1989	3 M	Danville, New Hampshire
1989	2 M	Catskill, New York
1988	5 M	Cocranville, Pennsylvania
1987	3 M	Hudson, Colorado
1986	9 M	Somerset, Wisconsin
1984	4 M	Everett, Washington
1983	9 M	Winchester, Virginia

Trouble Signs

Increased Tire Volume

Permit/Code Violations

Changes in Ownership

Company Bankrupt

Personnel Turnover

Loss of Permit

IGNITION QUESTIONS

1. What is the typical source of ignition in waste tire piles?
2. How can you protect tire piles from lightening strikes?
3. What measures should be taken to prevent accidental starts?

Codes & Regulations Objective

To recognize the benefit of a unified enforcement program.

To apply state regulations and national standards to waste tire facilities.

Enforcement Authority

CIWMB Title 14
CDF-SFM Title 19 (soon)

Local Fire Department
National Standards
NFPA & UFC

Local Health Department
Vector Control

Unified Enforcement

Environmental Crimes Task Force
HazMat Investigators
Building Code Officials
Fire Officials
Law Enforcement
Department of Health
District Attorney
CIWMB & USEPA

Regulations

No Federal Regulations

National Standards Include:

2002 NFPA 230, Annex F
"Guidelines for the Outdoor
Storage of Tires"

2000 Uniform Fire Code
Sections 1103.3.6
"Outside Storage of Tires"

2000 ICC International Fire Code Chapter 25
"Tire Rebuilding and Tire Storage

California Regulations

California Integrated Waste
Management Board
Title 14 Public Resource Code

Pending Legislative Approval
California State Fire Marshal
Title 19 Public Safety Code

California Regulations

Integrates the more restrictive
provisions from both model codes.

The differences in storage
requirements provides an example.

Storage Comparison

Subject	UFC	NFPA
Dimension	50' X 100'	50' X 250'
Height	10 ft	20 ft
Area	5,000 sq ft	12,500 sq ft
Volume	50,000 cu ft	250,000 cu ft
# Tires	19,100	95,500

California Regulations

Permitted- known location and operation. The owner has applied to CIWMB for a permit.

Unpermitted- tires dumped on a property with or without the knowledge of the property owner. Sites are generally hidden and unknown to enforcement agencies.

500 tires or 5,000 tires?

California Regulations

Emergency Response Plan

The owner/operator shall maintain a copy of the emergency response plan and forward it to the local fire department.

California Regulations

Fire Control Measures

Communication Equipment
(if the site is staffed)

Fire Control Equipment
(fire extinguishers, shovels, pike pole)

Optional Tools and Equipment
(per fire authority direction)

California Regulations

Fire Control Measures

Water Supply

1,000 gpm for 3 hours
at facilities with fewer than
10,000 whole tire equivalents

2,000 gpm for 3 hours
at facilities with more than
10,000 whole tire equivalents

California Regulations

Facility Access and Security

Signage
(at the entrance with contact info)

Controlled Access
(through an on-site attendant)

Access Road
(passable for emergency and vector
control vehicles at all times)

California Regulations

Facility Access and Security

No storage within 10'' of property line

Separated from vegetation and combustibles by 40'

Fire Lanes between piles

Controlled Ignition Sources (smoking, welding etc.)

California Regulations

Tire Storage Limits

No more than 5,000 square feet

No more than 50,000 cubic feet

No more than 10 feet high

No higher than 6 feet high within 20 feet of property line

California Regulations

Tire Storage

Separation Distances Between Tire Piles, Structures and Fire Lanes

Exposed Face	Tire Pile Height (ft) 6	8	10
25	50	56	62
100	84	100	116
150	99	117	135
200	111	130	149
250	118	140	162

California Regulations

Surface Water
Drainage & Containment

No Storage on Grades

Shall not be sited on 100 year flood plain

Tires must be removed from rims

SITE VISITS

Do you see a problem?
How would you
have it corrected?

California Regulations

INDOOR STORAGE

Operators may attempt to avoid outdoor storage regulations by moving their inventory indoors.

Waste tires stored indoors must meet the sprinkler requirements in NFPA 13.

RINGS OF FIRE

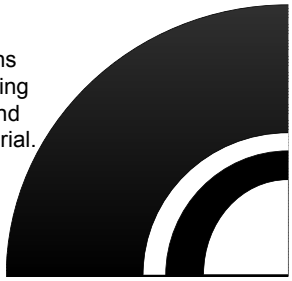
Part II
Fire Prevention

Regulations

1. Can the local fire authority enforce the CIWMB regulation?
2. Which national standard is more restrictive for tire storage?
3. Why shouldn't tires be stored on a grade or slope?

GROUND RUBBER OBJECTIVE

To provide recommendations and suggestions for inspecting facilities that generate ground rubber from waste tire material.



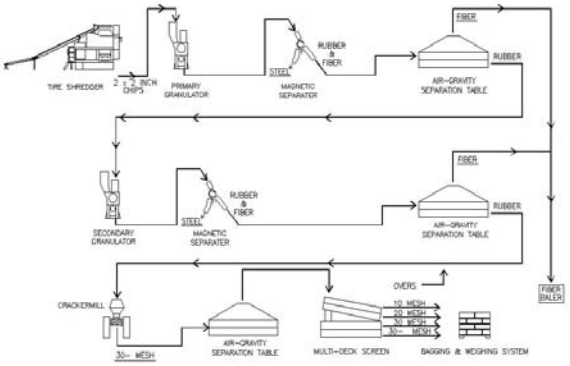
GROUND RUBBER

Ground rubber facilities require a
feedstock of waste tires stored on-site.

Retreading shops create ground rubber
as a by-product of their operation.

Fires in ground rubber facilities are common.

GROUND RUBBER



GROUND RUBBER

Industry Recommendations

Add 10 foot fence
around material storage.

Keep rubber piles 30 to 60 feet
from perimeter fencing.

No open flames allowed
near rubber material.

GROUND RUBBER

Industry Recommendations

Rubber pile should be
frequently rotated off-site.

Material should be kept
sheltered from precipitation.

In the processing line
clean-out rotor assembly.

GROUND RUBBER

Industry Recommendations

Install dust collection system.

Keep processing area clean and
clear of combustible materials

Install fire suppression system.

GROUND RUBBER

Industry Recommendations

Dust velocity of 2,500 to 3,500 feet per
minute to prevent fine rubber particles
from settling and plugging the system.

Though 5,000 to 5,500 feet per
minute will keep the ductwork clean.

Air flow sensors should be installed
in ductwork to monitor velocity.

GROUND RUBBER

Industry Recommendations

Install automatic shutdown of fans and manual shut-off switches near operator.

Install suppression system with the ability to flood the ductwork with water or steam.

Bag house dust collection systems should be pretreated to remove small fibers.

Nomex bags are recommended.

GROUND RUBBER

ALTERNATE MEANS OF PROTECTION

The California Code of Regulations allows the local fire authority to evaluate alternative means of protection.

Local conditions and new technologies may allow for additional ways to protect tire or ground rubber piles from a fire.

GROUND RUBBER

1. A local fire inspector should look at which areas of a ground rubber operation?

2. Why is it important to for the equipment operator to be able to shutdown dust collection fans?

3. What technology would you recommend to a ground rubber operator concerned about the temperature of the ground rubber pile?

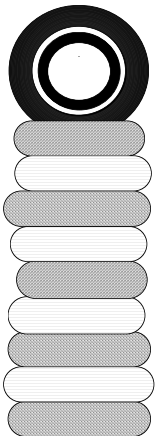
Emergency Response

Preplanning

Fire Behavior

HAZMAT

Main Menu



MAIN MENU

Background

Prevention

Response

Exit

PREPLANNING OBJECTIVE

To develop a site specific emergency response preplan.

PREPLANNING

CONSIDERATIONS

Mutual Aid - Assignments - Org Chart

Incident Command - Unified Command

Recognition as a Hazmat incident

Site Specific Information

Access to State and Federal Agencies

List local contractors and specialized equipment

PREPLANNING

LOCATION

Exact location & size of the tire storage yard

Type of facility (permitted or unpermitted)

Type of operation

The approximate number of tires

Maps of the site

Access points

The possible locations for command post

PREPLANNING

GEOGRAPHY

Topography Maps
Aerial Photography
Soil composition
Site Drainage
Hydrants and water supply sources
Roads and fire lanes
Fuel load configurations

PREPLANNING

EXPOSURES

High Risk; Schools, homes, hospitals and transportation routes near the site

Evacuation routes

Utilities (electric or gas lines)

Storm drains or plumbing systems

Buildings and heavy equipment

PREPLANNING

TIRE PILE COMPOSITION

The composition of the tire pile should be considered since important differences exist in developing suppression strategies.

Whole, Shredded, chip, or crumb tire piles

On rim or off rim

Other salvage or hazardous chemicals/waste.

The age of the pile and the local climate may affect the amount of rodent and insect infestation of the particular site.

PREPLANNING

IDENTIFY CONTACTS

Emergency contact for other agencies

Heavy equipment and repair

Construction and wood supply companies

Fill dirt and gravel contractors;

Canteen or food services providers;

PREPLANNING

IDENTIFY CONTACTS

Sanitation or "Porta-John" companies;

Public and private universities -

Foam/chemical additives manufacturers;

Oil reclamation and clean-up

Aerial photography and Infrared reconnaissance sources

RINGS OF FIRE

Part III
Fire Suppression

PREPLANNING QUESTIONS

1. What are your primary concerns for a tire fire?
2. Should those concerns be part of the preplan?
3. Why is it important to know the age and exposure of a tire pile?

FIRE BEHAVIOR OBJECTIVE

To identify the stages of a tire fire.

To identify the burn characteristics of whole and altered tire material.

To encourage site operators to take an active role in fire prevention and protection.

FIRE BEHAVIOR

Tire Fire Dynamics

The ability to absorb heat makes tires more difficult to ignite than ordinary combustibles.

1. Incipient or Ignition and Propagation Stage

2. Free Burning (Compression, Equilibrium and Pyrolysis) Stage

3. Smoldering Stage

FIRE BEHAVIOR

Ignition and Propagation Stage

Tires begin to decompose between 410 °C and 538 °C.

Burn rate is approximately 2 square feet every five minutes.

The rate accelerates 50 percent after the first ten minutes of burn time.

FIRE BEHAVIOR

Ignition and Propagation Stage

In this stage the tire pile should be pulled apart, using hand tools (if practical) or heavy equipment, separating the burning tires from the rest of the pile.

FIRE BEHAVIOR

Free Burning: Compression Stage

Tires flatten characterizing the beginning of the compression stage.

Open flaming and forward pressure is produced with an increase in heat and smoke.

The heat contributes to the collapse of the tires building downward pressure.

FIRE BEHAVIOR

Free Burning: Compression Stage

Protecting exposures, buildings, equipment and other tire piles is the best course of action.

FIRE BEHAVIOR

Free Burning: Equilibrium and Pyrolysis Stage

A tire pile fire reaches equilibrium when the level of fuel conversion is approximately equal to the available amounts of heat, fuel, and oxygen.

Low open surface flames
Fire is deep-seated
Internal temperatures 1,100 °C
Slow and complete fuel consumption

FIRE BEHAVIOR

Free Burning: Equilibrium and Pyrolysis Stage

Continue to protect exposures, allow the fire to consume as much fuel as possible.

FIRE BEHAVIOR

Free Burning: Equilibrium and Pyrolysis Stage

Fire spread influenced by tire configuration.

Whole tires will burn down to the middle of the pile.

Fire spreads on the surface of shredded tire and ground rubber piles.

FIRE BEHAVIOR

Smoldering Stage

During the smoldering stage- products of incomplete combustion are still being released.

Of particular concern is pyrolytic oil- which will begin to pool and run-off and/or leach into the soil.

One passenger tire releases approximately 2 gallons of pyrolytic oil.

FIRE BEHAVIOR

Smoldering Stage

The smoldering phase allows for a safe and aggressive attack on the fire.

Pull the smoldering pile apart using heavy equipment and incrementally extinguish the fire with water or foam.

FIRE BEHAVIOR

Smoldering Stage

It is possible for the heat from the tire pile fire to ignite the pyrolytic oil creating a secondary flowing oil fire.

As the fire slows along the edges and the outer surfaces cool, intense heat is trapped internally, making it extremely hazardous to open up the tire pile.

FIRE BEHAVIOR

Site Operators

The first line of defense at a tire pile fire.

- Conduct a Fire Safety Audit
- Appoint and Organization Staff
- Develop Emergency Procedures
- Fire Drill Procedures and Training
- Maintain Facilities & Equipment
- Maintain Access for F.D.
- Prepare Site Plans
- Post Emergency Procedures and Phone Numbers

FIRE BEHAVIOR

General Firefighting Procedures

With tire fires, each phase of the fire must be completed before the next phase can begin.

Rescue/Evacuation
Exposure Protection
Confinement
Extinguishment
Overhaul/Site Remediation

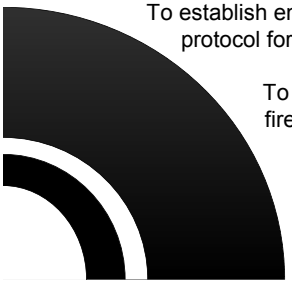
FIRE QUESTIONS

1. What stage is a tire fire in when the tires begin to compress?

2. What is pyrolytic oil and why should you worry about it?

3. Should your department help tire operators develop an effective site safety plan?

HAZMAT OBJECTIVE



To establish emergency response protocol for large tire pile fires.

To determine the right firefighting techniques for the emergency.

To recall safety considerations

HAZMAT RESPONSE

"S" Safety
"I" Isolation
"N" Notifications
"C" Command & Management
"I" Identification & Assessment
"A" Action Planning
"P" Protective Equipment
"C" Containment & Control
"P" Protection Actions
"D" Decontamination & Cleanup
"D" Disposal
"D" Documentation

HAZMAT

"S" Safety

Personnel Safety First!

Assess Potential Dangers:
Criminal Trespassers
Hostile Property Owners
Live Wires
HAZMAT
Tire Pile Instability
Heavy Equipment
Wildlife

RINGS OF FIRE

Part IV
Firefighter Safety

HAZMAT

"I" Isolation

Hot Zone: The area immediately surrounding the tire pile fire.

Warm Zone: The area for personnel and equipment decontamination including control points for the access corridor.

Cold Zone: The contains the command post and other support functions that are deemed necessary to control the incident.

HAZMAT

"N" Notifications

State and local Police
Public Works agencies
Office of Emergency Services
FEMA
US EPA
CAL EPA
CDF/SFM
Finance, Purchasing and Budget
Local Resources

HAZMAT

"C" Command & Management

Incident and Unified Command
Size-Up
Ensure Safety
Develop Tactics & Strategy
Order Evacuations
Contain Toxins
Order Resources

HAZMAT

"I" Identification & Assessment

Pyrolytic Oil
contains target compounds:
Naphthalene, anthracene, benzene, thiazoles, amines, ethyl benzene, toluene, and various metals such as, cadmium, chromium, nickel and zinc.

NFPA Hazard Label Health 3, Flammability 2, and Reactivity 1

HAZMAT

"I" Identification & Assessment

Ash
Contains various heavy metals including lead, arsenic, and zinc.

NFPA Hazard Label Health 3, Flammability 2, and Reactivity 1

HAZMAT

"I" Identification & Assessment

Smoke
Contains VOCs, SVOCs, PAHs, particulate metals, heavy metals, carbon monoxide, dioxins and furans, sulfur and nitrogen oxides, PCB's and acid gases (hydrochloric, and sulfuric).

NFPA Hazard Label Health 3, Flammability 2, and Reactivity 1

HAZMAT

"A" Action Planning

Life Safety
Exposure Protection
Confinement (Containment)
Evacuations
Extinguishment

HAZMAT

"A" Action Planning

Life Safety
Exposure Protection
Evacuations

Extinguishment Options:
Control Burn
Earth Cap
Extinguish- Water/Foam?
Heavy Equipment
Environmental Considerations.

HAZMAT

"A" Action Planning
Extinguishment

Fire Suppression Costs

EPA $2.5 Million Westley Fire

Tracy Fire Department
$450,000 Tracy Fire

HAZMAT

"P" Protective Equipment

Helmet
Turnout Coat
Turnout Pants
Nomex Hood
Latex Gloves (secondary protection)
Firefighting Gloves
Boots
SCBA
Tyvex Suits (optional)

HAZMAT

"P" Protective Equipment

Heavy Equipment
Operators need to be
trainined on safety
equipment and SCBA.

HAZMAT

"C" Containment & Control

Use Heavy Equipment:

Remove unburned tire
piles from path of fire.

Use dirt or sand to create
berms around fire area.

HAZMAT

"P" Protection Actions

Evacuate, Elderly, children, and
people with respiratory problems.

Shelter-in-Place for all others.

HAZMAT

"D" Decontamination & Cleanup

In the Warm Zone
Decontaminate
Personnel
& Equipment

HAZMAT

"D" Disposal

Tire fire clean-up costs are expensive. Fire Department involvement is usually limited to exposure protection for personnel and equipment involved with site remediation.

Remediation Costs
16 Million Westley Tire Fire
12 Million Tracy Tire Fire

Tires, metal, and all other debris must be disposed of at a CIMWB approved site.

HAZMAT

"D" Disposal

Recycling pyrolytic oil:
Petroleum refinery as a fuel oil product
Authorized oil recycler for blending into fuel
Tire manufacturer plants to make new tires
Asphalt plant

Cal-EPA classifies pyrolytic oil as a “hazardous waste” so pyrolytic oil must be sent to an approved oil recycling facility.

HAZMAT

"D" Documentation

The lead agency should prepare and publish a detailed report which includes the following information:

1) Site Background
2) Fire Cause & Tire Fire Dynamics
3) Potential Threats
4) Agency Response and Unified Command
5) Fire Suppression Tactics
6) Health and Safety
7) Environmental Sampling and Monitoring
8) Preliminary Site Assessment Results
9) Lab Reports
10) Lessons Learned

HAZMAT QUESTIONS

1. What is the best response protocol for a tire fire?
2. What is the best method to extinguish a tire fire?
3. How much foam should you order when the sales rep calls during the tire fire?
4. What are the major safety concerns at a tire fire?